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A DISEASE OF BLACK OAKS CAUSED BY POLYPORUS OBTUSUS BERK.

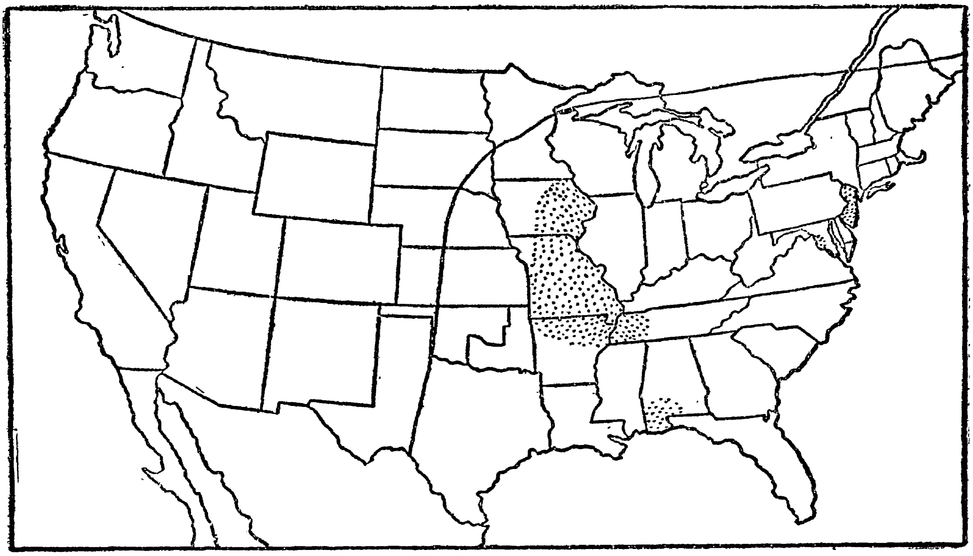
BY PERLEY SPAULDING.

Of the numerous fungi which attack living deciduous trees by gaining entrance through wounds or dead branches, *Polyporus obtusus* is not very generally known. The disease caused by this fungus is quite destructive locally to several species of oak trees which are of minor importance as timber trees. Because so little seems to be known of this fungus, and also because of the ever increasing importance of the inferior timber trees, it has seemed advisable to find out as much as possible concerning this disease, which has been discovered in certain localities in central Missouri and northern Arkansas. The disease which is caused by the fungus *Polyporus obtusus* in living trees of *Quercus marilandica* and *Q. velutina* has been found only in the above mentioned places, but it is more than probable that it is present in many others where it has not been noted. Because of the insects which eat the sporophores very rapidly, usually totally destroying them and rarely leaving a single one intact for any length of time, the damage caused by the fungus is very hard to estimate and it is impossible to determine the percentage of diseased trees. The thick, dark-colored, deeply furrowed bark covers injuries very effectually so that it is impossible to detect affected trees unless the sporophores are still upon them.

Polyporus obtusus seems to occur only in North America. In the United States it has been collected and reported from widely scattered localities as follows: Alabama by Mohr and Underwood & Earle; Arkansas by Hedgcock and Spaulding; Iowa by Holway, McBride, and von Schrenk;

Maryland by Ricker; Missouri by von Schrenk and Spaulding; New Jersey by Ellis; Tennessee by von Schrenk.

As stated above, this fungus seems to be limited to North America, as no references have yet been found citing its occurrence elsewhere. Berkeley, who published the first description of it, mentions a "Mr. Drummond" who collected the type specimens, probably while with Franklin on his second journey to the polar sea. Very probably the collection was made in Canada, but where, cannot be ascertained.



DISTRIBUTION OF BLACK OAKS AND FUNGUS.

This fungus seems to be limited as to its hosts as well as in distribution, for it is reported only from different species of the oaks. Berkeley, who named it, gave no host; Ellis in his North American Fungi number 309 records it from "dead standing trunks of *Quercus coccinea;*" McBride found it on "bur oak" trees killed by fire; Underwood and Earle found it once on *Quercus rubra;* Mohr reports it from *Quercus texana;* von Schrenk has found it on the black oaks; and the writer has found it on trees of

Quercus marilandica and *Quercus velutina*. In all cases where the scientific name is given so that there can be no mistake as to the identity of the host, the fungus is seen to occur only on members of the "black oak" group. The range of the different host species has been ascertained and covers the region east and south of the curved black line in figure, including the eastern portion of the United States. The localities from which the fungus is known are indicated by stippling. In this way one may see what is the probable distribution of the fungus and in what localities it is likely to be found in the future.

As far as there is any mention made, the inference is that *Polyporus obtusus* is a saprophyte only, and there is not the slightest hint of its occurring as a wound parasite. Living trees of *Quercus marilandica* and *Quercus velutina* have been found by the writer in two quite widely separated localities with this fungus occurring as a wound parasite. It not only grows on the trees but it sooner or later causes the death of the affected trees.

On investigation it was found that the sporophores were growing out of the entrances of burrows made by some wood-boring insect. The insect itself has not been seen but the burrow corresponded exactly with the descriptions of the work of an oak-boring insect known as *Prionoxystus robiniae* Peck. This insect is mentioned by Packard* as occurring from Maine to Texas and California in the wood of the oaks. It works on living trees and burrows in heart and sap wood alike. The moth is two and possibly three years in reaching maturity. Red oak is attacked in Maine. Packard found it in pin oak at Houston, Texas, and it is said to attack willow in some sections. It is known from California and probably occurs wherever black, red, and white oak and locust trees grow in this country. Fitch† says "It perforates a hole the size of a half inch auger, or large enough to admit the little finger. * * * This hole running inward to the heart of the tree, and admitting the water thereto from every shower that passes, causes a decay in the wood to commence and the tree never regains its previous soundness." The moth seems to lay her eggs on either healthy or injured trees with no decided preference for either one. The burrows found with the fungus growing in them were partly in apparently perfectly sound trees and partly in trees having some injury partially healed over.

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* Packard, Report U. S. Entomological Commission. **5**: 53–58. (1890).

† Fitch, Report on the noxious, beneficial and other insects of the State of New York. **5**: 4. (1859).

The spores of the fungus were evidently blown into the entrances of the burrows and the fungus then started to grow and followed the burrow until the heart of the tree was reached. The heart wood itself becomes affected and the rot extends throughout the wood of the tree trunk until the top is broken over by the wind or the weight of the tree.

As stated above the disease has been found occurring locally in Missouri and northern Arkansas in trees of *Quercus marilandica* and *Q. velutina*. In the places where found, the timber had formerly been cut off and a new growth of mixed oaks had taken the place of the cut forest. This new growth was very thick and reached the height of about twenty-five feet, and six inches in diameter. The sporophores appeared within about six or seven feet of the ground below the lower branches of the trees. In the localities where the disease was found nearly all of the trees of the two species mentioned above were affected, while the trees of white oak which were scattered among the others were never seen to have the fungus upon them. This is just what one would naturally expect under the circumstances, as the insect seems to have a preference for the two affected species and not to attack the white oak at all.

The rot extends up and down in the heart wood until the tree is so weakened that it breaks over or dies outright. All gradations in the severity of the disease were found between those where the rot extended only a very short distance from the burrow itself (plate 18, figure 1) and those with the tree nearly or quite dead, and having practically all of the wood rotted (plate 19, figure 1). As the disease progresses in the heart wood the sap wood becomes affected, in that it constantly becomes thinner and thinner until the death of the tree, which latter event is usually caused by the sap wood becoming so thin that it cannot any longer hold the weight of the upper parts of the tree, or the sap wood becomes so affected that it can no longer carry on its proper functions in supplying water to the upper portions of the diseased tree. As above mentioned, the rot in the early stages extended only a few inches each way from the original infection, but in the late stages the whole tree trunk may become affected for its whole length. From what could be gathered by observation, it seemed that the fungus works remarkably fast in causing the death of the attacked trees.

The heart wood of the black oaks is naturally rather dark in color but when affected by *Polyporus obtusus* it turns a light yellowish tint and in the last stages becomes almost white. The diseased wood retains its fibrous appearance but breaks much easier than does the healthy wood. It does not have the shrinkage cracks which are so characteristic of some of the wood rots. Neither does the affected tissue crumble between the fingers nor break very easily into small flakes. Wherever there is room enough for such formations to occur, strings and sheets of mycelium are formed, which are nearly or quite white in color. In trees which are not yet badly affected the color turns darker as we go from the rotted portion toward the bark of the tree until we reach the unaffected sap wood. In quite badly diseased trees there is a more or less distinct darker line at the edge of the heart wood, while the sap wood itself is darkened where it is apparently taking on the characteristics of heart wood prematurely. A tree which has a sporophore upon it is always more or less seriously affected and the rot extends from a few inches to as many feet longitudinally in the tree.

In the earlier stages of the disease the cell walls do not seem to have any single component extracted to any very serious extent. In the last stages of the disease, however, there are quite extensive streaks and patches of cells in the spring wood which have been so affected that their walls give the cellulose reaction. These areas are always located in the early wood of the annual rings, but the late wood still retains its normal yellow color. On testing the wood it was found that the white portions turned blue with chlor-iodide of zinc, and the cells are very readily seen to have the middle lamellae dissolved so that the cells separate from each other. The wood fibres are seen lying loosely beside each other and stained blue with chlor-iodide of zinc. The starch, which is commonly so plentiful in the medullary rays, is wholly absent in the whitened tissues. In the earlier stages of the rot scattering medullary ray cells are found containing considerable quantities of starch. These starch grains took the blue color and seemed to be rather smaller than normal. In medullary ray cells of medium stages of the disease a quite definite layer is seen lining the cell and not taking the stains for lignin and also not taking the stain for cellulose. Tests made upon the white tissues of the early wood of the annual rings seemed to show that the lignin was wholly extracted. Maule's potassium permanganate test gave a bright red only in the unaffected tissues. This was true also with phloroglucin and other lignin tests, while chlor-iodide of zinc gave the blue reaction in the white and worst affected tissues. As mentioned above, the middle lamellae were dissolved wherever the lignin was extracted from the walls.

Comparatively few instances have yet been recorded where the larger fleshy fungi attack trees by means of insect burrows. Probably the best known case is that of *Polyporus volvatus* * Peck, which has been found by von Schrenk to occur exclusively in the burrows of certain insects. *Polyporus pinicola* † is also said to enter trees by the same means. *Schizophyllum alneum* and *Lentinus lecomtei* have been found by the writer growing in insect burrows in standing trees. *Polyporus rimosus* is mentioned by von Schrenk ‡ as follows: "Infection takes place through the older branches and through the tunnels made by the locust borer." There are undoubtedly many of the Polyporaceae which occasionally enter trees in the same manner.

The writer desires to avail himself of this opportunity to express his thanks to the Director of the Missouri Botanical Garden for the use of the facilities of the Garden in this and other work done by him at the Mississippi Valley Laboratory of the United States Department of Agriculture, located at the Garden.

EXPLANATION OF PLATES.

Plate 13. — 1, Upper surface of a sporophore of *Polyporus obtusus* Berk. 2, Lower surface of a sporophore of *Polyporus obtusus* Berk. The large irregularly shaped pores are well shown.

Plate 14. — 1, *Polyporus obtusus* Berk. growing out from the entrance of a burrow of *Prionoxystus robiniae* in a tree of *Quercus marilandica*. This tree was but slightly injured by the fungus. 2, Sporophore of *Polyporus obtusus* Berk. in burrow of oak borer on a tree of *Quercus velutina*. This and the preceding figure show the general shape of the fungus sporophore very well.

Plate 15. — 1, *Polyporus obtusus* on a tree of *Quercus marilandica*. The tree is but slightly affected in the neighborhood of the insect burrow.

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* von Schrenk, Bull. Div. Phys. & Path., U. S. Dep. Agric. 25:13–14. (1900).

† Spaulding, Report Mo. Bot. Garden. **15**: 75–76. (1904).—von Schrenk, Bull. Div. Veg. Phys. & Path., U. S. Dept. Agric. 25: 14. (1900).

‡ von Schrenk, Report Mo. Bot. Garden. **12**: 24. (1901).

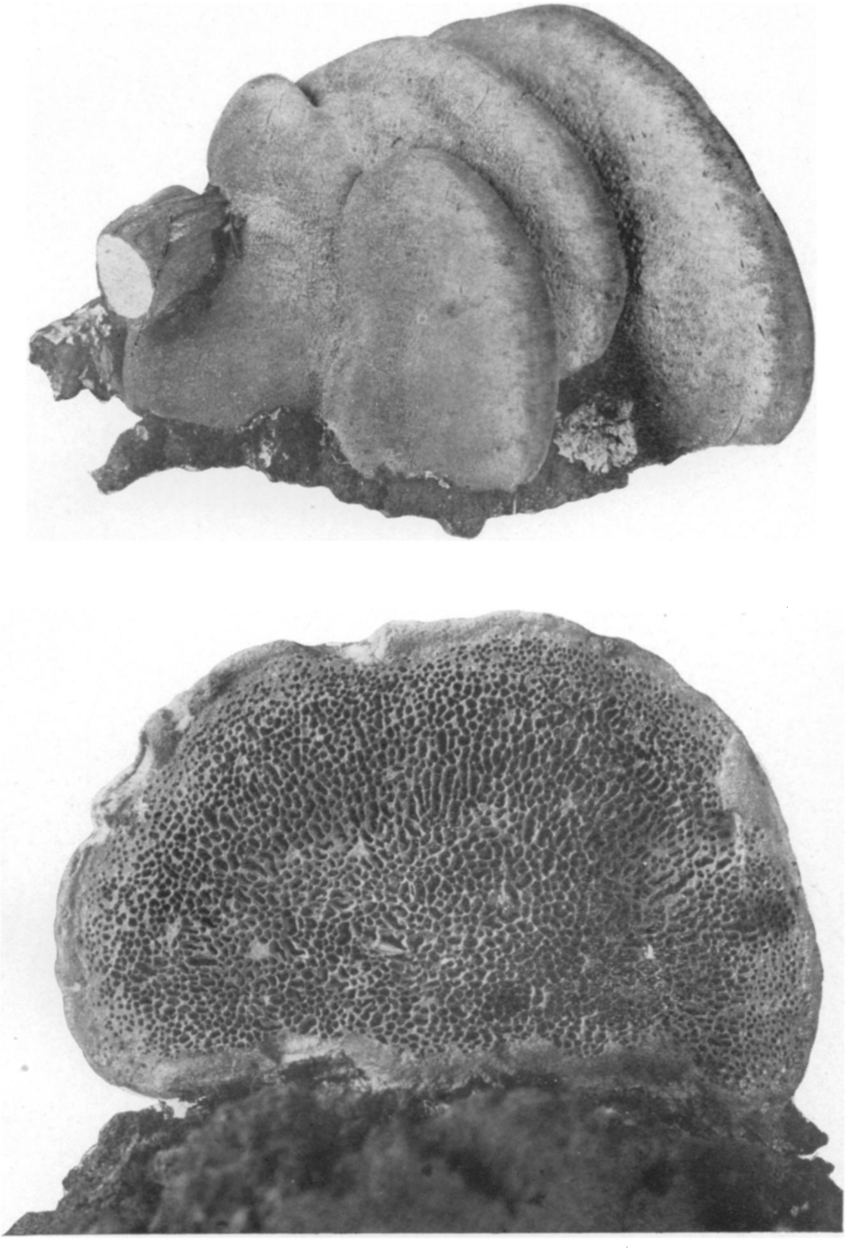
2, A tree of *Quercus marilandica,* killed by *Polyporus obtusus* Berk. The trunk is rotted throughout heart and sap wood.

Plate 16. — 1, Cross section of a tree of *Quercus marilandica* rotted by *Polyporus obtusus* Berk. Only a small part of the heart wood is here affected. 2, Cross section of a tree of *Quercus velutina* showing the rotted heart wood with an insect burrow partially filled with the mycelium of *Polyporus obtusus* Berk.

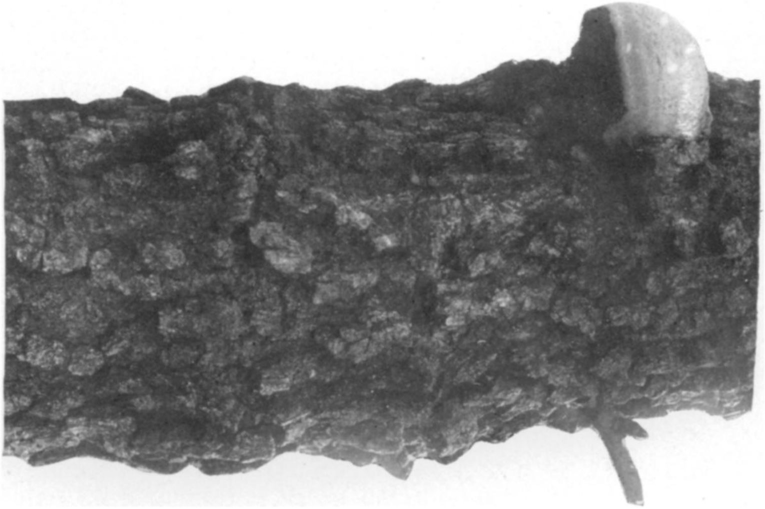
Plate 17. — Stem of *Quercus velutina* split to show the insect burrow, which is on the left side, running upward from the opening in the bark midway the length of the block toward the center of the tree. To the right and above the upper end of the burrow is seen the lighter colored rotted heart wood. The burrow is filled with a mass of mycelium of the fungus, *Polyporus obtusus* Berk.

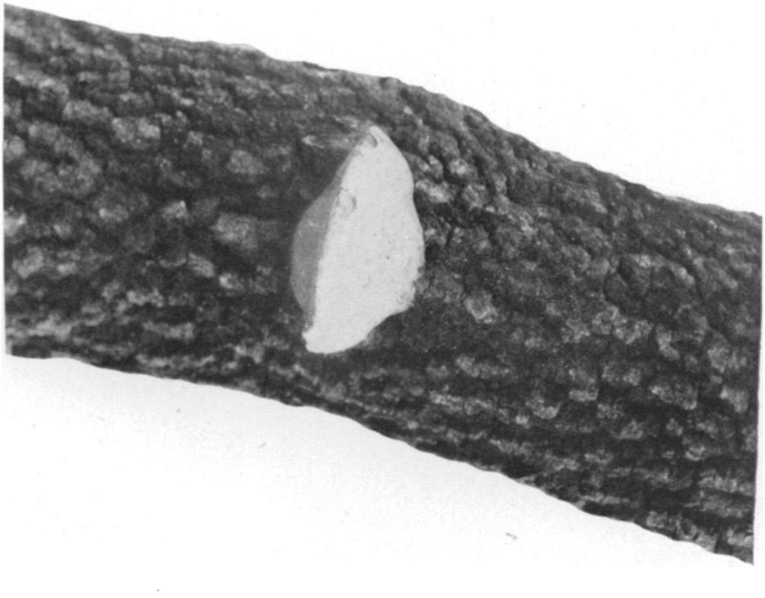
Plate 18. — Section of a tree of *Quercus marilandica* with an insect burrow on the right. There is but a small area of white rotted wood adjacent to the burrow.

Plate 19. — Section of a tree of *Quercus marilandica* which was killed by the fungus. The insect burrow shows very plainly. The entire stem was rotted except on the extreme left next to the bark, where a thin darker layer of the sap wood is seen.

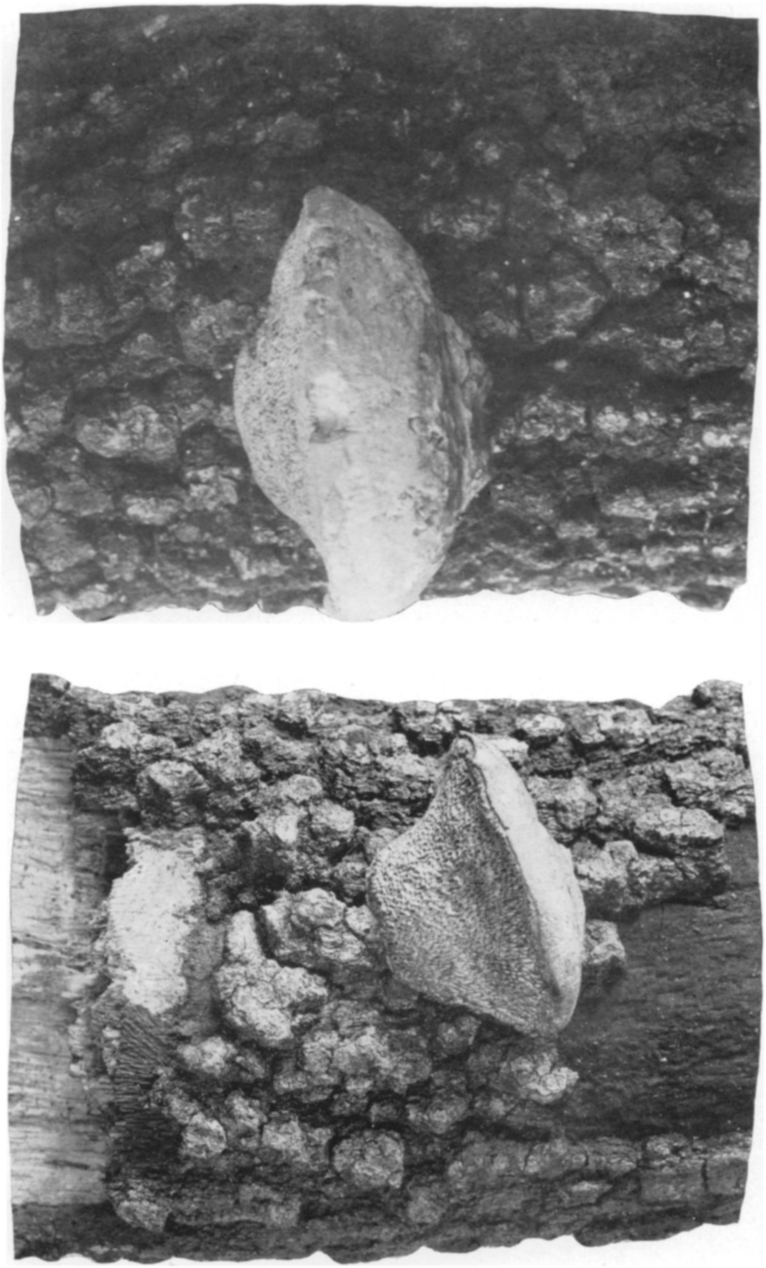


POLYPORUS OBTUSUS.

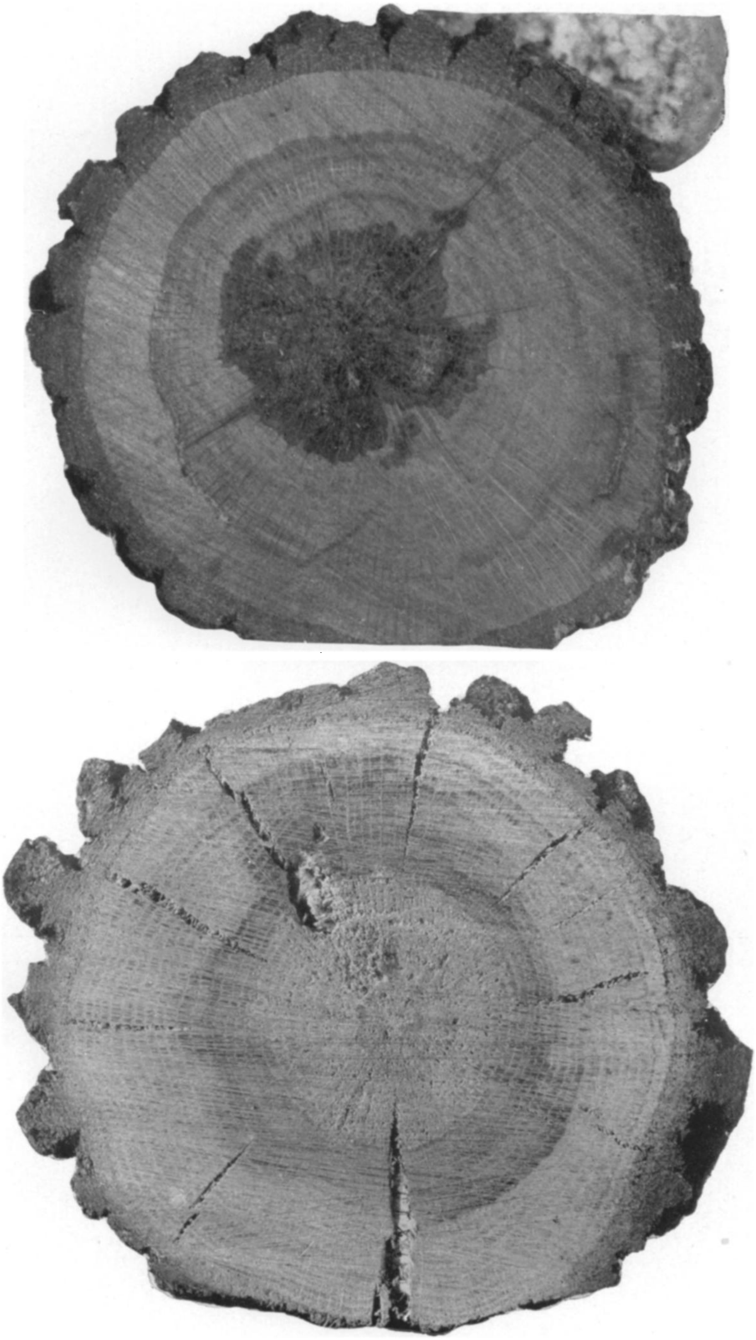




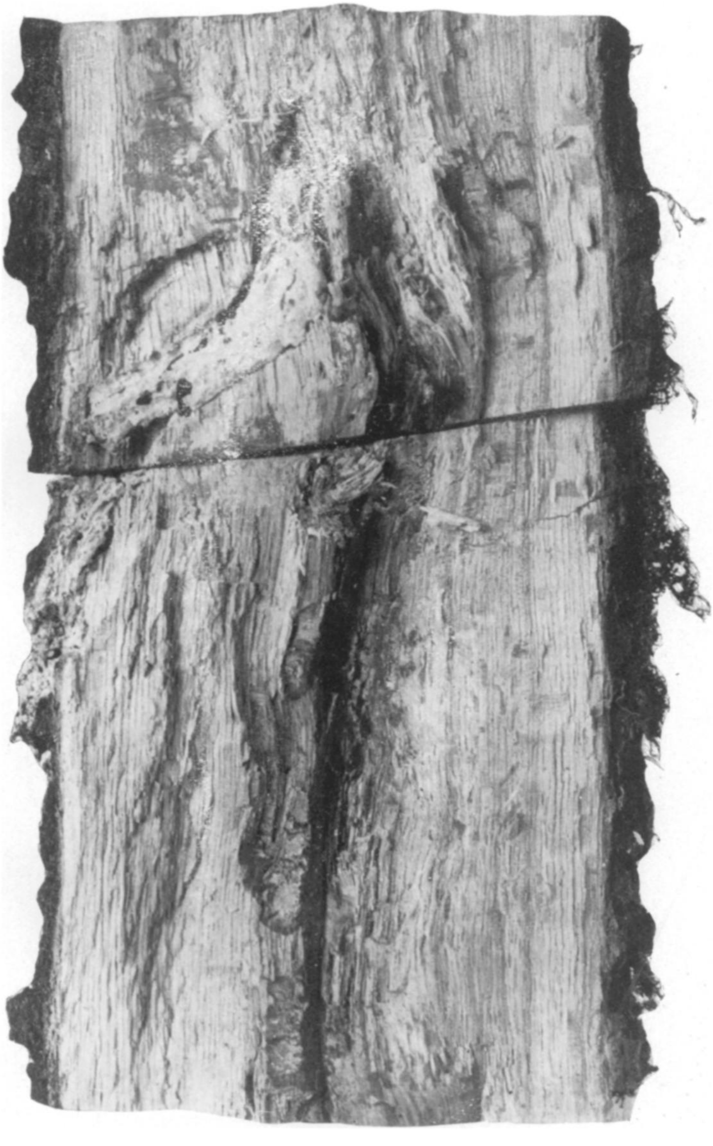
POLYPORUS OBTUSUS.



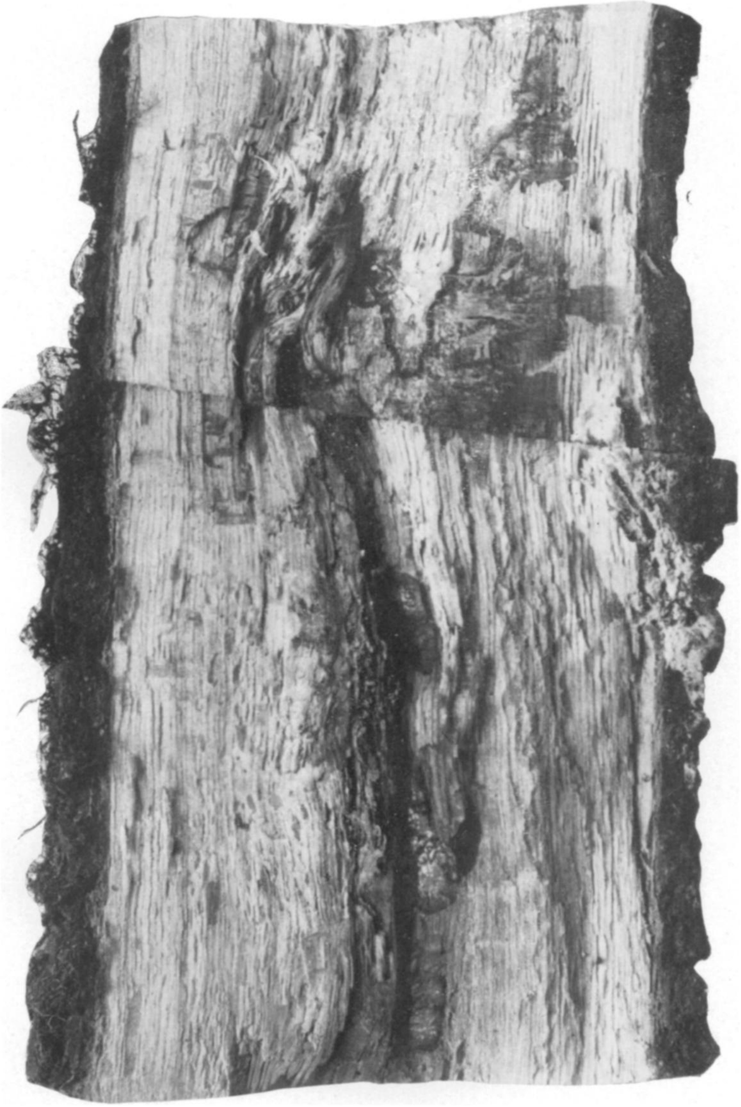
POLYPORUS OBTUSUS.



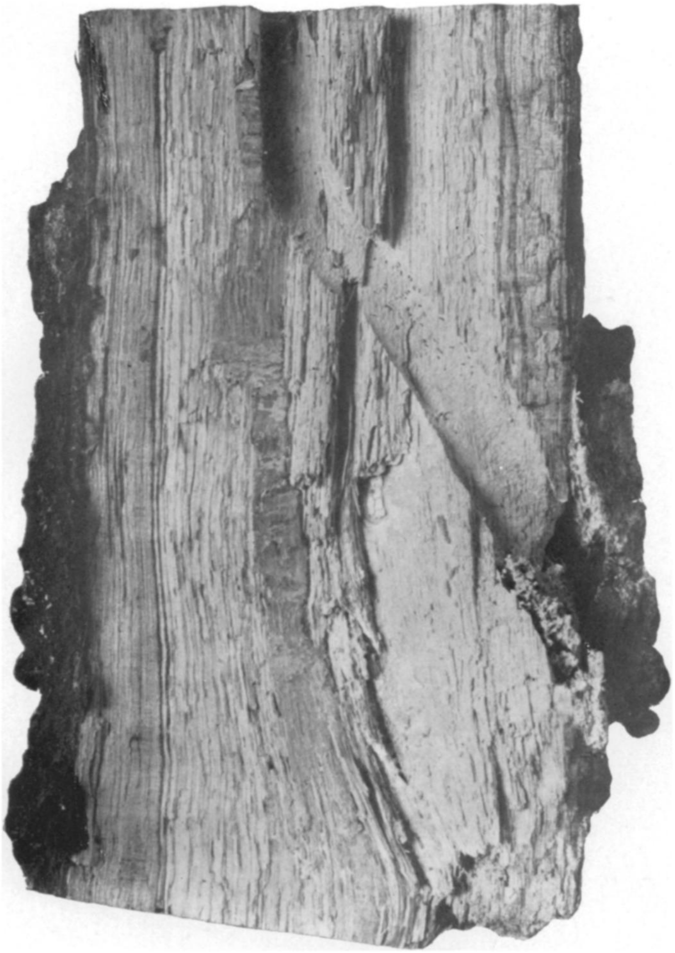
ROTTED OAK WOOD.



PRIONOXYSTUS BURROW IN OAK.



PRIONOXYSTUS BURROW IN OAK.



PRIONOXYSTUS BURROW IN OAK.